High-Resolution Infrared Atmospheric Remote Sensing and Applications

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Unique high-spatial resolution measurements of the Earth are made with the airborne Multispectral Atmospheric Mapping Sensor (MAMS) in support of NASA's Mission to Planet Earth Program. The MAMS is a multispectral scanner that flies on board an ER2 high-altitude aircraft and measures reflected radiation from the Earth's surface and clouds in eight visible-near-infrared channels and thermal emission from the surface, clouds, and atmospheric constituents (primarily water vapor) in four infrared bands. The airborne scanner is used to make unique measurements of the atmospheric hydrologic cycle. The scanner views a 37-km-wide scene of the Earth from the ER2 altitude of about 20 km. Each MAMS footprint (individual field-of-view) has a horizontal resolution of 100 m at nadir. Since the ER2 travels at about 208-m/sec, a swath of MAMS data 37 by 740 km is collected every hour. The nominal duration of an ER2 flight is 6 hr (maximum of about 7 hr). The instrument is managed by MSFC and maintained by NASA's Ames Research Center.

A number of geophysical parameters important in studying the Earth's hydrologic cycle can be derived from the MAMS data. The resolution of each product varies with the desired parameter. Table 11 lists the parameters that can be derived from MAMS. Precipitable water and skin temperatures (land or sea surface) are derived with a physical split window algorithm.[1, 3, 5] The accuracy of precipitable water ranges between 2 to 5 mm (root mean square error) based on the MAMS calibration, quality of the first guess, the desired spatial resolution, and the sounding environment (poor performance occurs where temperature inversions exist). Sea surface temperature is retrieved quite accurately and not subject to the temperature inversion problem. Varying surface emissivity over land influences the quality of the land surface temperature retrieval. The Normalized Difference Vegetation Index (NDVI) is calculated from the ratio of visible to near-infrared channels as with LANDSAT and SPOT satellites. The absolute accuracy of NDVI depends on the channel gains and the pre-/post-flight calibration of the visible channels.[2] Upper-level humidity is retrieved with an empirical method.[4] Accuracy of the humidity field varies with MAMS calibration and the quality of locally generated retrieval coefficients. Clouds can be detected quite well with the multispectral channels of MAMS (even thin cirrus). The accuracy of cloud-top temperature and height assignment varies with MAMS absolute calibration and cloud emissivity. Absolute calibration degrades at cold temperatures and therefore cloud top information is the least accurate for the tallest (coldest) clouds.

Table 11.—*MAMS-derived parameters and their accuracy.*

Parameter	Resolution	Coverage	Accuracy
Total Precipitable Water	250–1,000 m	Over Entire Image	2–5 mm rms
Land Surface Temperature	100–300 m	Over Entire Image	0.1–1.0 K (Relative) 0.5–6.0 K (Absolute)
Sea Surface Temperature	100–300 m	Over Entire Image	0.1 K (Relative) 0.1–1.0 K (Absolute)
Normalize Difference Vegetation Index (NDVI)	100–300 m	Over Entire Image	5% (Relative) 5–30% (Absolute)
Upper-level Humidity (In Weighting Function Layer)	100–300 m	Over Entire Image	1–2% (Relative) 5–10% (Absolute)
Clouds			
–Detection	100–200 m	Over Entire Image	99% Efficiency
–Mean Top Temperature	100–200 m	Where Cloud Present	0.5 K (Relative) 0.5–6.0 K (Absolute)
–Mean Height (Pressure)	100–200 m	Where Cloud Present	50 mb (Relative) 50–200 mb (Absolute)

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[2]Jedlovec, G.J.; Atkinson, R.J.: "Variability of Geophysical Parameters From Aircraft Radiance Measurements for FIFE." *Journal of Geophyscal Research*, 97, 18913–18924, 1992.

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[5]Suggs, R.J.; Jedlovec, G.J.: “Evaluation of a Split Window Technique for the Retrieval of Geophysical Parameters From GOES.” In preparation for *Journal of Applied Meteorology*, 1996.

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Biographical Sketch: Dr. Gary Jedlovec is an atmospheric scientist in the Earth System Science Division at MSFC’s Global Hydrology and Climate Center. He conducts scientific research using measurements from satellites, aircraft, and ground-based systems in order to study the Earth’s hydrologic cycle. Dr. Jedlovec earned his Ph.D. degree in meteorology from the University of Wisconsin–Madison in 1987 and has worked for NASA for 11 years.